THE DEVELOPMENT OF DIGITAL TOPOGRAPHIC MAPPING

IN A STATE GOVERNMENT AUTHORITY

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ABSTRACT

In February 1983, the Graphical Photogrammetric Section of the Division of Survey & Mapping was decimated by a fire. In the re-equipping which followed, the Division acquired extremely modern equipment to continue the 1:25,000 topographic mapping program. Also included in the re-equipping phase was a digital mapping system to be used for a research project into digital mapping. Amongst various projects undertaken, the main development has been the creation of a small scale digital map of the State of Victoria. This product combines topographic information , mapping information, administrative and thematic information into a graphics data base across Victoria. A user interface has been developed to enable the data to be accessed easily, utilizing special menus and interrogation routines, and plot files or digital data sets may then be obtained.

NOTE: The views expressed within this paper are entirely those of the author and do not necessarily reflect those of the Division of Survey and Mapping.

INTRODUCTION

This paper centres mainly on the activities of the Digital Topographic Mapping Research Project (DTMRP) of the Research Section, and the Graphical Photogrammetric Section, both within the Division of Survey and Mapping, which forms part of the Department of Property and Services. The Division is a member of the National Mapping Council and is the official Victorian State Mapping Authority. The State of Victoria is located in the south-east corner of Australia and covers an area of 227,600 square kilometres and a population of approximately 4.5 million. These figures represent just under 3% of the total area of Australia with around 30% of the nation's population.

The Division's mapping programs presently involve the concurrent production of 1:25,000 standard series topographic mapping and 1:25,000 / 1:2,500 cadastral mapping. The Division is currently in the 4th year of an Accelerated Mapping Program which sees the production of around 120 topographical maps per year using internal and contracted production systems. The Accelerated Mapping Program is expected to run for a total of 8-10 years and was placed into operation because of the pressing need for a large scale mapping coverage to support functions such as long term economic, future development and rural planning needs. Full 1:25,000 topographic coverage of Victoria will consist of 1640 sheets.

DATA CAPTURE CAPABILITIES

In February 1983, the course of the Division, as far as topographic mapping was concerned, was well entrenched in a traditional program relying on equipment which had been in service for quite some time. The data capture program undertaken in the Graphical Photogrammetric Section relied on 18 stereoplotting instruments (Wild A8, A7, B8, B8S and Kern PG2). The section also had 10 major ancillary items such as Wild TA and Kern AT plotting tables to support these instruments. This equipment represented a replacement cost of approximately $A2,000,000.

In the early hours of Monday, 28th of February 1983, a fire detector signalled an alarm in the Government Offices complex at Treasury Place, Melbourne. Due to an incorrectly labelled indicator board, the fire units were led to the wrong area of the building. One and a quarter hours later, a fire was reported in the section of the building immediately below the Graphical Photogrammetric Section. This area housed chemical laboratories which serviced several Government Departments.

The fire proved extremely intense with explosions and heavy fumes caused by a range of chemicals stored in the laboratory. The fire was contained within an hour but explosions and minor ignitions continued throughout the day. These were caused by water contact with ruptured chemical containers.

Extensive damage was done to the building which is unusable to this day. The Graphical Photogrammetric Section suffered the greatest loss with either total destruction of, or serious damage to each of the 28 major equipment items. The damage was caused by a mix of direct fire, heat distortion, water damage or chemical vapours. This resulted in the total loss of the Division's togopraphic compilation capabilities and potentially severe disruption to the Accelerated Mapping Program.

Immediate problems of the accommodation of the staff involved and the restoration of some form of productivity were faced. Two stereoplotters were made available at the Royal Melbourne Institute of Technology, 4 stereoplotters were provided by the Army Survey Regiment and National Mapping also loaned 2 stereoplotters, in order to enable the resumption of the compilation process.

Equipment Replacement

An investigation into the re-equipping of this section was then carried out. Of the destroyed and damaged equipment, only 1 Wild B8, 2 Kern PG2's and 3 Wild TA plotting tables were restored. Only a very short time frame was allowed for the selection and replacement of the destroyed machinery.

The total mapping requirements of the state were again to be supported using both high and low order instruments. This also added an opportunity to cater for future developments in the areas of digital mapping and automation, especially with the emerging LIS/GIS technologies gaining prominence on the state scene. However the production of graphical 1:25,000 topographic maps was to remain the highest priority.

The destroyed equipment was replaced in two stages to supplement the equipment on loan and to enable some production to be maintained during this period. The equipment obtained through the phased acquisition process was:

2 Wild BC1 Analytical Stereoplotters
2 Wild TA2 Precision Digital plotting tables
7 Wild AG1 Analogue Stereoplotters
4 Wild TA Digital Plotting tables
2 Kern PG2 Analogue Stereoplotters
1 Wild OR1 Orthophoto System

Three of the AG1 stereoplotters were outfitted with Wild RAP computer based enhancement systems. Serial line communications were also installed between the 3 AG1-RAP systems and the BC1 analytical systems. At this stage, it was decided that an investigation into digital topographic mapping should be commenced within the Division, to take place within the Research Section.

THE DIGITAL TOPOGRAPHIC MAPPING RESEARCH PROJECT (DTMRP)

The DTMRP was established in late 1984 as a small research and development project. Two staff members were permanently attached to the project, with a third position being filled on a rotation basis by trainee draughting staff. An Intergraph Digital Mapping System, based on a VAX 11/730, was purchased to provide a focus for the operations of the

DTMRP. A single screen, monochrome graphics workstation, coupled with a large format, high precision digitizer formed the crux of the graphics system. The workstation was interfaced to a Wild AG1 to enable direct capture of digital data from aerial photography. The acquisition of this system along with the BC1 and AG1-RAP systems represented a major step for the Division into digital mapping.

After a period of familiarization with the system, the investigation proper was commenced. The initial terms of reference of DTMRP were to investigate the requirements of a digital topographic data base at a source scale of 1:25,000 for the state of Victoria. To this end, tests of direct stereoplotter digital data capture and manual digitization were commenced. Evaluations of the equipment, the data acquisition methods and the canvassing of user requirements (either actual or projected) were pursued.

A Digital Victoria

However, in May 1985, under the direction of the Surveyor-General, the DTMRP project team began studying the requirements for the creation of a small scale digital map of Victoria. A report detailing the possible source materials available, and the processes required for the creation of a digital product at a nominal scale of 1:1,000,000 was prepared. This special project is designed to be the initial mapping product of the Division.

Upon acceptance of the project team's recommendations, the DTMRP resources were committed to the development of the small scale map, known within the project as VICMAP. A recent map product developed within the Division was chosen as the base from which the topographic data could be digitized. A 1:1,000,000 tourist map had been developed in 1983, and the source base was available in the form of 4 1:500,000 base sheets. Stable based proof copies were prepared for the manual digitization process.

The standard projection used within Australia is the Australian Map Grid (AMG), a version of the Transverse Mercator projection based on the Australian Geodetic Datum. The coordinates used are metres, with zones of 6 degrees width and a central scale factor of 0.9996. This projection was however, not suitable for the VICMAP files as Victoria is split by a zone boundary. This raises considerable problems when trying to display the outline of Victoria within the one file using this coordinate system. One option considered was the use of geographical coordinates. This was also not chosen as there is a considerable distortion of the "accepted" image of the state outline as shown on the Transverse Mercator projection.

The projection chosen for the VICMAP task has been dubbed "Pseudo-AMG". It is a Transverse Mercator Projection which was created specifically for the small scale map of Victoria in 1981. It has a central meridian of 145 degrees east (which runs through Melbourne) and a central scale factor of 1.000. The zone width is unlimited enabling the State of Victoria to be digitized within a consistent coordinate system. Coordinates for control have been computed to the nearest metre from reduced AMG equations. Routines were developed to enable the conversion of the "pseudo" coordinate data to geographicals or AMG if so desired.

Using a classification of features based upon generalized topographic criteria for representation at the scale of 1:1,000,000, a digitization program was commenced. The initial data capture effort was concerned with the main topographic layers of information, the hydrographic pattern and the road network.

The positions of all population centres were also digitized during this program. A file of town names was developed through a map preparation process. Town names were placed in order of half degree squares. Coordinates corresponding to a position in the adjacent half degree square (to the east) were used to place all the town names into the file by software processes. It was then a simple, logical editing process to place a town name in its proper position to annotate the town location correctly. This proved to be a more efficient process than the operator keying in the name during the digitization process.

System development has been performed by DTMRP staff throughout the project. Software processes were developed to place various information layers into the system. The boundaries, names and numbers of the 1:25,000, 1:50,000, 1:100,000, 1:250,000 map sheets covering Victoria were placed into the graphics data base files by software processes. The current status of the 1:25,000 topographic mapping program is also held within the system.

Proofing of the content of the topographic data was done by the Cartographic Drawing Section to ensure that a complete coverage of topographic features was held. All information within the graphics data base files is feature coded and structured to enable manipulation and display of individual feature classes if so desired. Routines to ensure the correct codes are held throughout the digital data sets were developed.

Thematic and administrative information is also being incorporated into the VICMAP files. Land administration in the form of the Parish overlay for the state has been manually digitized. This proved to be a lengthy process. The parish data had been drawn against a 1:1,000,000 map of

Victoria, drawn in 1966, which was known to contain positional inaccuracies. To confound this problem, the parish base did not fit the base perfectly.

A careful map preparation and analysis process enabled the identification of many "control points" for the parish overlay. These were clear boundary intersections where known coordinates were available, and points that could be confidently matched to detail within the digitized topographic framework of stream and road patterns. The digitization of the parish network, containing 2004 parishes, was then performed by concentrating upon small, localized areas and performing a digitizer set up for each particular area. A computer file containing the 2004 parish names along with associated centroids, was used to place the names within the graphic file. The parish names are being thoroughly checked to ensure correct placement and also to counter problems with the size of the text in relation to the size of the parish itself.

Digital information was obtained from the Division of National Mapping, a Federal mapping authority, for use within VICMAP. The local government areas and the federal electoral boundaries within the State of Victoria were obtained from National Mapping. The data provided was still in a "raw" state and consequently some editing of the data was expected. This information was placed into the graphics files by software processes. It was found that a considerable editing effort was required for this data. The topographic base of stream and road networks, and the parish system were used as references to control the structure of the local government and federal electoral boundaries. As the vast majority of local government boundaries follow either a parish boundary, a river or a road, conflict frequently occurred. In all such cases the structure of the topographic base was adopted. Using the monochrome screen, we were quickly forced to adopt a system of exotic line styles and weights in order to discriminate between the lines we were looking at on the graphics screen.

The state electoral boundaries and various state department administrative regions are being manually digitized and will provide a comprehensive base of administrative information. This will prove to be of enormous use to state departments, especially those that require staff to be operating in the field, and already interest has been shown in the utilization of this information. The information stored within the VICMAP graphic data files is shown in Table 1.

TABLE 1

TOPOGRAPHIC BASE	OVERLAY INFORMATION	MAPPING INFORMATION
control	local government areas	1:25000 boundaries
coast	parishes	1:25000 names
lakes	counties ##	1:25000 numbers
rivers	federal electoral areas#	1:50000 boundaries
streams	legislative assembly ##	1:50000 names
minor streams	legislative council ##	1:50000 numbers
highways	post codes ?	1:100000 boundaries
secondary roads	various state departments	1:100000 names
minor roads	administrative boundaries ##	1:100000 numbers
unsealed roads?		1:250000 boundaries
railways?		1:250000 names
state boundaries		1:250000 numbers
cities		
towns	1:25000 status data: - on program]	
villages	(topographic program)- compiled]quarterly	
localities	- provisional] updates	
major islands	- printed]	
minor islands		

\# - currently undergoing digitization or editing
- to be commenced
? - possibly to be included

One important factor being ensured is that the various thematic layers form a consistent, homogeneous base of information across the state. In all cases the structure of the topographic base has been adopted as the controlling framework upon which the other layers are established.

Output Capabilities

Wild TA2 high precision flat bed plotters are used to provide a range of high quality cartographic outputs, including the preparation of scribed negative plots. Considerable effort has been put into the development of a plotting optimization package to make more efficient use of the available time on the TA2 plotting tables, which are generally dedicated to the operations of the BC1's. Also developed has been a package to provide optimised positive/negative photographic plots on a Gerber flat bed plotter, which is available on a contract basis. The optimizing package was developed in order to minimize the

movement of the pen turret with the pen or scribing tool up. The package strings together adjacent line strings or locates the nearest line string for plotting.

High quality cartographic products, derived from the VICMAP data, have already been provided for use in a state government commission into the re-structuring of local government in Victoria. The commission's activities have a very high public and political profile, and consequently are operating on a restricted time frame. Therefore, when maps were required for use by members of the commission as working tools and for inclusion in published reports, manual methods for the production of such documents was impossible in the time available. However, using the data stored within the VICMAP project, many different maps were provided in a large range of scales and formats within a short time frame.

The other main product of this project is the digital information itself. The data can be provided in various formats, the most notable being the Australian Standard for the Interchange of Feature Coded Digital Mapping Data, AS 2482.

To enable the use of the data by people with little experience with the computer graphics system, menus and software have been developed to enable the 'tailoring' of the images or data sets required. Interrogation procedures have been set up to enable the location of areas of interest by the entry of items such as : map name or number, town name, parish name or local government name.

APPLICATIONS AND FUTURE DEVELOPMENT

The creation of the VICMAP graphics files has opened up a new avenue of customised mapping for the Division. There has not been such a comprehensive and consistent base of information available before and it is consequently generating considerable interest. Effectively the VICMAP project can be seen as a small scale GIS.

The ability to provide customised products in a variety of formats is of great benefit. Conventional processes are not practical in many cases because of the photographic processing required, the inflexibility of the layout and the large times involved for creation of special layouts. The performance of the product and the system has been tested well by the work done for the Local Government Commission.

Planned developments to the VICMAP system include the creation of generalization routines to enable the derivation of smaller scale digital products. The mounting of the VICMAP product information on a PC sized machine is also

being considered for use in areas such as education. There is also a number of projects with which the DTMRP may become involved. The development of a National Wilderness Inventory is being pursued at two levels, national and state. The Victorian effort is at the forefront of the current proposals and the participation of the Division, utilizing the DTMRP system and National Mapping, in a joint venture with staff of the Arthur Rylah Institute and the CSIRO is progressing.

Also under consideration is a major pilot project studying the rural salinity problems. This project would require the digitization of quite a number of 1:25,000 topographic maps, as well as numerous thematic and natural resources overlays. Such a project would have obvious benefits, enabling a reasonable introduction to the task of the creation of a digital topographic data base for the state of Victoria and the requirements of a state-wide GIS.

The major agencies in Victoria that manage land related programs all hold the belief that the 1:25,000 topographic coverage being developed by the Division of Survey and Mapping will provide the best base for the creation of a GIS to handle the long term needs of Victoria.

Another in-house project which may be of great benefit, would be the establishment of the translation of raw data files created on the BC1 systems and the AG1-RAP systems into a structured format on the Intergraph system. With still a third of the state to be mapped, this process could prove to be of inestimable value to the long term requirements of the state.

CONCLUDING REMARKS

The Division of Survey and Mapping is actively progressing into the new age of mapping with the acquisition of high technology equipment to conduct its topographic mapping program and the Digital Topographic Mapping Research Project. The equipment that is now in use has a great capacity to be of enormous value in the production of a state wide digital data base of topographic information.

The development of the small scale digital product has shown some of the benefits that may accrue from such a data set. A second workstation providing colour graphics display is being added to the Research Project, due to the success of the VICMAP project. This is planned to cater for the use of VICMAP both in-house and by external users. Involvement in future projects will only confirm that there are many benefits to be achieved from the use of digital mapping data.

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